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The Genus Cyathea (sensu lato) in Malaysia

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I have lately completed a study of the family Cyatheaceae for *Flora Malesiana* (Holttum, 1963), and have been led to formulate a new arrangement of infra-generic groupings of species within a comprehensive genus *Cyathea*. The present paper presents comments on this classification, and incidentally poses some questions which may be relevant to a consideration of the classification of the species of tropical America.

In the area covered by *Flora Malesiana* there are almost 200 species of *Cyathea*. In the mainland of Asia and the adjacent non-Malaysian islands I can distinguish only 24 or 25; in the Pacific and Australasia are 50 to 60 species (no full comparative survey of these has yet been made). There is no species in mainland Asia or the Pacific region which has no close relative in Malaysia. Thus a discussion of the genus in Malaysia applies in essentials also to the species of these other regions.

The traditional basis for a classification of this group of ferns long has been the character of the indusium, upon which Robert Brown (1810, p. 158) established the genera *Hemitelia* and *Alsophila* as distinct from the earlier *Cyathea* Smith (1793, p. 416). Although there were some minor differences as between different subsequent authors in the definition of these genera, the generic characters may be thus broadly summarized: in *Cyathea* the indusium is cup-shaped, in *Hemitelia* it is attached only on one side of the receptacle, and in *Alsophila* there is no indusium. Careful inspection with the use of modern opti-

cal equipment shows this to be an over-simplification, and indeed Hooker (1844, pp. 28, 34) had some understanding of this, but the use of the three genera persisted for over a century. Copeland (1909, p. 353) was the first to point out clearly that, in the Malayan region at least, the grouping of species provided by the generic definitions is unnatural. His solution was to include all species in one genus, *Cyathea*; but other authors thought that though this might be right for Malaysia, it was not necessarily so for species of the American tropics, for which reason Christensen continued the use of the three genera in the third *Supplement* to his *Index Filicum* (1934, pp. 20, 58, 110), though in his taxonomic papers on ferns of Malaysia he followed Copeland (1934, p. 218).

Copeland (1947, pp. 98, 99) later attempted to segregate two genera in Malaysia, namely *Gymnosphaera* Bl. and *Schizocaena* J. Smith, but in my judgment he did not clearly define them and included in each case diverse elements not conforming to the characters of the type species; in particular, he overlooked the characters of the scales (Holttum 1957, pp. 41-45). I believe that it is possible to establish two natural groups of species around the type-species of *Gymnosphaera* and *Schizocaena* (including in each case some that Copeland retained in *Cyathea*); but both groups seem to me to be parts of larger groups, and I do not think the latter are sufficiently distinct to warrant generic separation. This judgment is supported by cytological evidence; the haploid chromosome number in all species investigated (including some from each of my major groups), is 69.

My two major groups within *Cyathea* are: subgenus *Cyathea*, having flabelloid stipe-scales, and subgenus *Sphaeropteris* (Bernh.) Holttum having setiferous scales. The distinction between these groups is not only in the characters of the edges of the scales but also in their development (Holttum & Sen 1961, p. 410). It appears to me that, judged by other characters also, this division is a natural one, though it is difficult to describe the differences in precise terms. The following is a conspectus of the subgenera and their sections.

SUBDIVISION OF THE GENUS CYATHEA IN MALAYSIA

Stipe-scales flabelloid; hairs on lower surfaces, if present, crisped and appressed; pinnules in most cases deeply lobed, basal basiscopic vein rarely from costa; indusia in many cases hemitelioid.

Subgenus CYATHEA

Indusiate (indusia in some cases very small) or if exindusiate hairy on lower surface of pinna-rachis; axes not very dark; little dimorphism between sterile and fertile pinnules.....Section *Cyathea*

Exindusiate; axes very dark, not hairy beneath; fertile and sterile pinnules usually very dimorphous.....Section *Gymnosphaera*

Stipe-scales setiferous; hairs on lower surfaces, if present, rather thick and spreading; where pinnules are shallowly lobed, basal basiscopic vein always from costa; indusia complete, or lacking, or formed of separate scales (in a few cases imperfect, and then not hemitelioid).

Subgenus SPHAEROPTERIS

Costules not widely spaced (rarely over 4 mm. apart in pinnules 10 cm. long); pinnules usually 10 cm. or more long, lobed almost or quite to costa throughout, or fully pinnate.....Section *Sphaeropteris*

Free tertiary leaflets few; indusia present or absent; sori never covered with overlapping scales.....Subsection *Sphaeropteris*

Free tertiary leaflets many; no indusia; sori covered with overlapping scales.....Subsection *Fourniera*

Costules widely spaced (at least 4 mm. apart except where pinnules are under 4 cm. long); pinnules mostly less than 10 cm. long, not lobed to within 1 mm. of costa except near base; basal basiscopic vein always from costa; indusiate or not.....Section *Schizocaena*

Scales of stipe 1 cell thick throughout.....Subsection *Schizocaena*

Scales of stipe thick and fleshy at base, tapering and flat distally.

Subsection *Sarcopholis*

Each subgenus is divisible into two sections. Subgenus *Cyathea* comprises the sections *Cyathea* and *Gymnosphaera* (Bl.); subgenus *Sphaeropteris* comprises the sections *Sphaeropteris* and *Schizocaena* (J. Sm.). The sections *Gymnosphaera* and *Schizocaena* have the same type-species as the genera of the same names recognized by Copeland, but a different assemblage of other species.

Species which lack indusia, and have therefore in the past been included in the genus *Alsophila*, are to be found in section *Gymnosphaera*, section *Sphaeropteris* and section *Schizocaena*. In sections *Sphaeropteris* and *Schizocaena* there are both indusi-

ate and exindusiate species; the exindusiate species in each section seems to me more nearly related to the indusiate ones within the section than to exindusiate species in other sections. In section *Gymnosphaera* there are no indusiate species, but there are exindusiate species which appear to be on the borderline between sections *Gymnosphaera* and *Cyathea*. Thus, in my view, Copeland's statement that a genus *Alsophila* defined solely by absence of indusia is an unnatural one is amply justified.

But another definition of a genus *Alsophila* R. Br., and by modern standards a more important one, is that it is a genus which includes the original species of *Alsophila*, namely *A. australis* R. Br. This certainly does not belong to section *Gymnosphaera*, as it lacks the characteristic dark axes and constricted fertile lamina; it lacks also small scales with dark median band shown by Miss Tindale to be normally present in that group (1956, p. 331). I would place *A. australis* in subgenus *Cyathea* section *Cyathea*. In its scales it is near *C. pruinosa* Rosenst. and other indusiate species of New Guinea, but it has no indusium. It has, however, a variable number of small scales attached to the base of the receptacle, and in this resembles *Alsophila aspera* (L.) R. Br. of the West Indies (the scales in *A. aspera* are much larger than in *A. australis*). This might seem to justify the inclusion of *A. aspera* in the genus *Alsophila* as typified by *A. australis*. But some other tropical American species which are included in *Alsophila* (as defined by lack of indusium) lack such scales and are in other ways very different.

It is interesting to note that in the subgenus *Sphaeropteris* a much larger number of species have small scales attached to the base of the receptacle, and in the subsection *Fourniera* these scales are usually quite large, overlapping and covering the sorus almost to maturity; the subsection *Fourniera* is characterized also by almost fully tripinnate fronds. The Malaysian members of this subsection (*C. celebica* Bl., *C. tripinnata* Copel. and others) have been described as indusiate, but are not so; the scales which appear to form an indusium are quite separate, and have the cell-pattern of scales, not of indusia.

The section *Schizocaena* appears to me a very natural one. In it I include the species which Copeland placed in *Gymnosphaera* sect. 3, which have scales exactly like those of the type species of *Schizocaena*. I include also some indusiate species (*C. integra* J. Sm. and allies) which Copeland placed in *Cyathea*. I exclude the Ceylon species *Cyathea sinuata* Hook. and *C. hookeri* Thw., which have very different scales and appear to me most nearly related to some species in Madagascar, not to any others in Asia.

I have rather tentatively subdivided *Schizocaena* into two subsections, based on the fact that in New Guinea and the Pacific are species which have stipe-scales arising from ascending fleshy bases; these I place in the subsection *Sarcopholis*. I am however not sure whether there is a sharp distinction between these species and those with large thin scales, and I have not seen good fresh material of any species with fleshy scale-bases, so that I do not understand their structure and development.

Subgenus *Cyathea* section *Cyathea* is by far the largest section, and includes species with indusia of every kind. Sen and I have argued that the *Hemitelia* type of indusium is primitive in the genus, and homologous with the "inner indusium" of *Dicksonia*. I suggest that the cup-shaped *Cyathea* indusium has evolved, perhaps on several distinct lines, from the *Hemitelia* type. There are species in Malaysia which show transitions between a *Hemitelia*-type of indusium and a shallow cup-shaped one, sometimes on the same leaflet, notably *C. javanica* Bl., and *C. sumatrana* Bak. In Ceylon, the species *Cyathea walkerae* Hook., as usually interpreted, comprises forms with shallow cup-shaped indusia as well as the normal form with a conspicuous hemitelioid indusium, and I have also seen one with a very small indusium attached to one side of the receptacle and quite hidden by the sporangia. Very small indusia of this type are characteristic of several species in Malaysia (e.g., *C. latebrosa* (Wall.) Copel.); such species were placed in the genus *Alsophila* by Baker and other 19th century taxonomists because with their optical equipment they did not see the indusia. A very similar

small indusium occurs in *Alsophila aquilina* Chr. of tropical America. Maxon thought this so different from the indusium of species of *Hemitelia* in tropical America that he saw no obligation to transfer *A. aquilina* to Hemitelia (1928, p. 317). But in Malaysia there is every gradation from very large hemitelioid indusia to very small ones, and nearly all are dark at the base, as that of *A. aquilina.* I wonder therefore whether *Hemitelia* in the American tropics can be clearly distinguished on indusial (or other) characters from Old World species which have been called *Hemitelia.* Among the latter is *H. capensis* (L. fil.) R. Br., which occurs also in South America, so that the distinction is not a geographical one. If a clear distinction can be established between New World *Hemitelia* (in Maxon's sense) and Old World ones, then the former should retain the name *Hemitelia;* but I suggest that it ought to be as a section of the subgenus *Cyathea.* However, a comprehensive monograph of all tropical American species of Cyatheaceae is necessary before the status of such a group can be fairly judged.

Just as I think the cup-shaped (typical *Cyathea*) type of indusium developed on more than one evolutionary line, so also the exindusiate condition developed on various lines by loss of the indusium. In Malaysia one can see every stage of reduction down to complete loss, in the species I have placed in section *Cyathea.* I have not seen such transitions among tropical American species, but I have not attempted a full survey of them. I would only call attention to the remarkably similar vegetative character and scales in the type-species of *Cyathea, C. arborea* (L.) Sm., and in the quite exindusiate *Alsophila leucolepis* Mart.; surely these two species must be rather closely related.

The Malaysian species formerly called *Cyathea* in the strict sense have sori completely covered by indusia almost to maturity. In some cases the indusium finally opens at the top and forms a perfect cup with a smooth rim; in other cases the swelling sporangia break the indusium, the final form of which is a cup with torn edges. There are other species the indusia of which superficially resemble this latter condition at maturity.

and have been described as cup-shaped, but which have in fact large indusia of *Hemitelia*-form; an example is *C. oinops* Hassk. of Java. The indusium here is attached only to the costular side of the receptacle but covers the top of the sorus like a hood. In *C. spinulosa* Wall., where the indusium is very thin and is partly lost on breaking, the sori look like a true *Cyathea* when they are young and like *Hemitelia* when they are old; specimens in the latter condition were called *Hemitelia decipiens*.

One fact that puzzles me considerably is that the hemitelioid condition does not occur in subgenus *Sphaeropteris*; one finds only complete indusia which break at maturity (never truly cup-shaped with smooth rim) or none, except in the few cases where there appear to be hybrids, in which various forms of rudimentary indusia occur, but not the hemitelioid condition. This consistent absence of hemitelioid indusia is another indication of the distinctness of subgenus *Sphaeropteris*. But if the *Hemitelia* form of indusium is the primitive form in *Cyathea*, it must have been present in *Sphaeropteris* ancestors, and presumably has died out.

The case of the probable hybrid group called *Cyathea alternans* (Wall.) Pr. is of considerable interest. *C. alternans* is very variable, not only in the extent to which the pinnae are lobed or partially pinnate, but also in the development of the indusium, and there is no clear correlation between indusial form and extent of lobing of the pinnae. Some specimens show quite complete indusia, others every gradation down to a small irregular disc round the base of the sorus (only detectable by very careful observation). The presumed parent species are *C. moluccana* R. Br. (which is simply pinnate and normally has a complete indusium) and *C. squamulata* (Bl.) Copel. (quite exindusiate and fully bipinnate).

Though *C. moluccana* normally has complete indusia, many specimens have been found, especially in Borneo, which are vegetatively like normal *C. moluccana* but have only small fragments of an indusium, much as in some specimens of *C. alternans;* Copeland gave the names *C. pseudobrunonis* and *C. kinabaluen-*

sis to such specimens. It seems to me possible that this may be a case where suppression (or almost complete suppression) of the indusium has passed from one species to another as the result of a long series of hybridization; but I see no indication of the reverse process of the development of an indusium in ferns like *C. squamulata.* The nearest indusiate bipinnate species is *C. assimilis* Hook., but this seems to be quite distinct.

There are tropical American species which (as judged by scale characters) appear to belong to the subgenus *Sphaeropteris;* those I have noted are *C. crassipes* Sod., *C. insignis* Eaton and *C. princeps* (Linden.) Meyer. These are all indusiate (indusia quite covering young sorus, breaking irregularly at maturity) whereas a majority of Malaysian species of subg. *Sphaeropteris* lack indusia. A careful comparison of these tropical American species with Malaysian ones having similar scales seems to me desirable.

After long study of all the many Malaysian *Cyathea* species, I believe I have found natural groupings among them; but I do not see how those groupings can apply to tropical American species. It appears to me that a full monograph of New World Cyatheaceae is much overdue, and I hope someone will find the time and patience to attempt it. Only by such a comprehensive study can inter-relationships within the family be apprehended. The study of a limited number of species may be helpful as a preliminary, but conclusions based on a small sample may not be valid when considering the whole.

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A New Species and Variety of Bolbitis from India

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Recently a detailed morphological study of the genus *Bolbitis* was undertaken by the Pteridology Laboratory of the National Botanic Gardens (India), and in this connection several species of the genus from different parts of India were collected and studied (Nayar, 1960; Kaur, 1962). During November and December, 1962, two new types of *Bolbitis* were collected from the Castle Rock area in the Western Ghats of South India. They were transferred to the fernery of the National Botanic Gardens at Lucknow, along with specimens of *Bolbitis presliana*, *B. semicordata*, *B. subcrenata*, and *B. virens*. One of them matches *B. semicordata* (Moore) Ching, except that its rachis and stipe are narrowly winged and the margins of the pinnae are conspicuously lobed. It is described as a variety of *B. semicordata*.

The other is a large fern forming extensive colonies on gravelly soil on the western slopes of the hills in deep shade. This appears to be an unrecorded species and is described below. Herbarium specimens of both new ferns are deposited in the Herbarium of the National Botanic Gardens, Lucknow, India.

BOLBITIS **kanarensis** Nayar & Chandra, sp. nov.

Rhizoma repens ca. 2.5 cm. diam., crassum dense paleaceum, filis sclerenchymatis in pulpa centrali dissitis praeditum; paleae atrofuscae lanceolatae, basi auriculatae, acuminatae, glanduloso-ciliatae; folia bifaria alterna in dorso rhizomatis; frondes steriles ca. 150 cm. longae, pinnatae, apice elongato linguliformi pen-